Reduction in Mean Biochemical Oxygen Demand [BOD_5] Due to Tree Cover

This EnviroAtlas community map estimates the annual change (kg/yr) in mean concentration of biochemical oxygen demand (BOD) measured in urban stormwater runoff due to filtration by trees within each census block group The estimates were produced using the i-Tree Hydro analysis tool developed by the USDA Forest Service. Biochemical oxygen demand was measured using the standard 5-day BOD test (BOD_5).[1]

Why is reduction in biochemical oxygen demand important?

Biochemical oxygen demand (BOD) is an indicator of the total amount of dissolved oxygen required by microorganisms to break down organic matter in a sample of stormwater. Higher BOD measurements indicate greater oxygen depletion in the sampled waterbody. Common sources of higher BOD in urban stormwater runoff include plant debris, animal waste, trash, gasoline and motor oil, heavy metals, fertilizers, and pesticides. As oxygen is depleted from surface water through the decomposition of organic matter, it degrades aquatic habitats and negatively affects the survival of aquatic life.[1]

Urban stormwater runoff contains untreated nonpoint source pollutants such as sediments, nutrients, and metals, which are deposited directly into local streams and lakes. Polluted stormwater runoff affects the hydrology, channel structure, and water quality of local waterways as well as recreational opportunities, public health, and community aesthetics and well-being for local residents.[2] The proportions of tree cover relative to impervious surfaces in community neighborhoods influence the quantity of urban stormwater runoff and the speed at which it enters nearby waterways. Impervious surfaces increase peak runoff magnitude following precipitation events.[3] Reduced dissolved oxygen concentrations in urban streams often occur soon after major storms because of this pulse of oxygen-demanding substances into streams.[2]

Urban tree cover can benefit communities by reducing the influx of organic materials that increase biochemical oxygen demand in local waterbodies. Trees in an urban setting intercept rain water, slow the passage of stormwater to drains, and filter out nutrients and pollutants. Toxic substances in organic pollutants may be modified by microorganisms in the soil into less harmful forms and made available for plant growth.[4]

This EnviroAtlas map helps to visualize the varying relationships among impervious surfaces, tree cover, and estimates of potential annual change in mean concentration of biochemical oxygen demand. Estimates of potential BOD reduction are lower in city center areas with higher impervious surface area and higher in suburban and rural areas having more tree cover. The BOD data layer can serve as an important planning tool for mitigating oxygen depletion in receiving waterbodies.

How can I use this information?

This map, Reduction in Mean Biochemical Oxygen Demand [BOD_5] Due to Tree Cover, illustrates variations in the reduction of pollutants in storm water runoff from filtration by urban trees. This layer can be combined with other community ecosystem service layers in EnviroAtlas (e.g., air pollution removal, carbon storage and sequestration, and air temperature effects) to calculate the magnitude of multiple ecosystem services contributed by trees within a given area.

Using this surface water runoff information, planners and other interested users can readily identify the community neighborhoods and block groups with the highest proportion of impervious surfaces where additional tree planting might improve the retention and filtration of runoff following heavy precipitation. Users might also overlay National Hydrography Dataset (NHDPlus) flowline data (available under the

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boundaries icon) to explore where tree planting would have the greatest return in terms of improving water quality in nearby waterbodies.

How were the data for this map created?

This data layer was derived from a high-resolution land cover map provided by the U.S. EPA for selected communities. To estimate the effect of changes in tree and impervious cover on runoff, the i-Tree Hydro model was run to simulate cover change effects on a local watershed. The model was calibrated using hourly stream flow conditions and was run numerous times to produce estimates of changes in runoff due to changes in tree and impervious cover. To estimate the block group effect, the runoff outputs of the watershed were determined for each possible combination of tree cover (0-100%) and impervious cover (0-100%). Thus, there were a total of 10,201 possible responses (101 x 101). For each block group, the percent tree cover and percent impervious cover combination (e.g., 30% tree-20% impervious) was matched to the watershed hydrologic response output for that combination (actual streamflow data). The hydrologic response outputs were calculated as either percent change or absolute change in units of kg of pollutant per square meter of land area (kg/m^2). These per square meter values were multiplied by the square meters of land area in the block group to estimate the tree effects at the block group level. The block group effect was assumed to be similar to the nearby watershed in terms of hydrologic effects.

To estimate the reduction in biochemical oxygen demand due to trees, national mean event-mean-concentration (EMC) values (measured as a mass of pollutant per unit volume of water [mg/l]), were multiplied by the volume of runoff to determine estimated changes in kg/yr of BOD.

What are the limitations of these data?

To generate the data for this map, modeled results for a local watershed were transformed into runoff results for the community census block groups. Trees within each block group were assumed to have a hydrologic effect similar to that of trees within the modeled watershed. For each block group, each percent tree cover and percent impervious cover combination was matched to the appropriate watershed hydrologic response output for that combination, even when the block groups were not within the modeled watershed. In addition, national water quality EMC values were substituted for actual local concentration values of runoff in each block group, which are unknown. Finally, the model is more diagnostic of cover change effects than predictive of actual stream pollutant load.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. To find the EnviroAtlas 1-meter land cover grids created for each community, enter *land cover community* in the interactive map search box.

Where can I get more information?

A selection of resources related to trees and urban runoff is listed below. For additional information on the data creation process, access the metadata found in the layer list drop-down menu for map layers in the EnviroAtlas interactive map. To ask specific questions about this data layer, please contact the EnviroAtlas Team.

Acknowledgments

The data for this map were generated by David Nowak, USDA Forest Service, and Tian Zhou, Bangshuai Han, and Ted Endreny, State University of New York. The fact sheet was created by David Nowak, USDA Forest Service, and Sandra Bryce, Innovate!, Inc.

Selected Publications

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2. The National Academy of Sciences. 2009. Urban stormwater management in the United States: 2009. Report prepared by the Committee on Reducing Stormwater Discharge Contributions to Water Pollution, National Academies Press, Washington, D.C.

3. Wang, J., T.A. Endreny, and D.J. Nowak. 2008. Mechanistic simulation of tree effects in an urban water balance model. *Journal of the American Water Resources Association* 44(1):75–85.

4. Nowak, D.J., J. Wang, and T. Endreny. 2007. Chapter 4: Environmental and economic benefits of preserving forests within urban areas: Air and water quality. Pages 28–47 *in* de Brun, C.T.F. (ed.), The economic benefits of land conservation. The Trust for Public Land, San Francisco, California.

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